Mark the Earth Lightly:
A Permaculture Framework in Graduate Design Studio

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PREMISE AND ORGANIZATION OF THE STUDIO

The intention of this studio was to change students' mindsets by challenging the inherited paradigm that sees humans as separate and apart from the workings of nature. This linear mode of thinking is instead substituted with an emphasis on interdependency and cyclical thinking. The notion that we would do well to imitate natural processes has great potential for architecture, at all scales from buildings to communities. Permaculture design principles, grounded in ecology and related disciplines, are rooted in the careful observation of the natural patterns of a particular site. The daily work of permaculture involves integrating human environments with natural cycles using ingenuity, manual labor, common sense and appropriate technologies. This design studio gave students the opportunity to learn from practicing permaculturists, and to work firsthand with these principles.

The project itself is the design of a master plan and residences for Heathcote, a 112-acre intentional community north of Baltimore, Maryland. As part of the School of Living, the members are committed to providing a working model of cooperative, sustainable living. They both practice and teach permaculture. Having just acquired 68 of the 112 acres, they need to formulate a master plan to accommodate growth and to organize the component functions of living, community, and education. They intend both existing and new buildings to be models of sustainable design, made of natural and/or recycled materials and utilizing sustainable technologies.

Teams of students researched different choices for materials and systems, such as strawbale, underground, reclaimed post and beam, structural earthen systems, alternative energy, energy efficiency, composting toilets, greywater, rainwater storage, "living machines," and recycled materials. The compiled information was evaluated for cost, availability, and feasibility. This data, detail drawings, and recommendations were presented to Heathcote members for use during the design charrette and later design stages.

Students then worked with community members and several professional technical advisors during a design charrette to explore different master-plan scenarios. The advisors included experts in natural building, renewable energy, ecological site planning, water resources, integrated design process, and energy efficiency. Each group consisted of a couple of students, one or two technical advisors, and representatives of Heathcote working together. At the end of the day, the groups presented their designs for a general discussion. The integration of different disciplines resulted in complex yet elegant proposals, with several themes running through the work.

One group analyzed both natural (immutable) and human-created (potentially mutable) systems influencing the site. They mapped existing and potential agricultural sites, forest cover, soils, steep slopes, water, septic areas, solar access, and zoning constraints. The interrelationships suggested by these overlays became the starting point for a master plan design. Another group thought about the natural hydrology of the site, using buildings to collect rainwater and greywater uphill from gardens in need of irrigation. Planners also suggested regenerative ideas such as planting the stream with a forest buffer to improve water quality. Ultimately, all acknowledged the importance of knowing the site well, including its soils, prevailing winds, microclimate, and solar access. This knowledge must be balanced by clear aspirations and a sense of what is sacred about the place.

Following the charrette, students worked on individual parts of the master plans. One team chose to focus on strengthening the heart of the community as a research and learning environment, centering on the existing barn, carriage house, and historic mill. Others looked at new enclaves of housing and community space, stepping up the hill from the stream valley. During this process, students struggled to integrate what they were learning about permaculture ethics and techniques. They had to work between specific practices and general underlying principles. The first half of the semester had focused sustainable design criteria more directly on architecture, but this project presented a much wider framework.

ECOLOGICAL ETHICS – QUESTIONING OUR PLACE IN THE WORLD

> *"By [ecological design] we mean design for human settlements that incorporates principles inherent in the natural world in order to sustain human populations over a long span of time. This design adapts the wisdom and strategies of the natural world to human problems. Implicit in this study there is a larger question – what is the role of humanity in the greater destiny of the Earth?" (Todd 1984, 1)*

We typically see ourselves at the top of the food chain, in charge of managing the planet, making liberal use of its plants, animals and minerals (which we lump together and call, "resources"). The author Paul Hawken has observed that this attitude has grave consequences. Modern industry is ruining the planet. We are, in essence, fouling our own nest. Every living system on earth is in decline and the rate of decline is increasing. However, Hawken is optimistic that business can solve these problems, and help bring human enterprise into balance with the natural world. (Hawken 1993, 3)

To succeed, we need an alternative way of understanding our place in the world. We can borrow from native or indigenous peoples, who see themselves as a part of the web of life. Whatever we do to the web, we do to ourselves. The key is to see our environment – both built and natural – as a single system, in which everything is interrelated. We can learn to emulate natural systems, such as the ability to recycle all wastes so that nothing is considered a useless throwaway. Permaculture design principles rely on this ancient wisdom to *think* and *act* responsibly in relation to each other and the earth.

One could say that these principles derive from ecology. Humans are indeed beholden to ecological laws, the same as any other lifeform. The most irrevocable of these laws says that a species cannot occupy a niche that appropriates all resources; there has to be some sharing. Any species that ignores this law winds up destroying its community to support its own expansion. (Benyus 1997, 5)

Essentially, ecological thinking accepts the interrelatedness of all elements within a given system, and seeks to understand how they influence and interact with each other. David Orr defines ecological design, as "the careful meshing of human purposes with the larger patterns and flows of the natural world and the study of those patterns and flows to inform human purposes. [This] means maximizing resource and energy efficiency, taking advantage of the free services of nature, recycling wastes, and . . .incorporating intelligence about how nature works. . . into the way we think, design, build, and live."(Orr 1994, 104)

The author Janine Benyus refers to the practice of biomimicry, which uses an ecological standard to judge the "rightness" of our innovations. It is a new way of viewing nature as model, measure, and mentor. (Benyus 1997) If we are a part of nature, then it follows that our creations themselves are "natural." The question is, are they *well adapted* to life on earth? Life on earth has learned everything it needs to live here without mortgaging its future. And it can do amazing things – fly, circumnavigate the globe, build soil, clean water, harness the sun's energy, live on the bottom of the ocean or at the top of Mount Everest. Life has essentially learned to create conditions conducive to life. Do our own artifacts do this? (Benyus 1999)

PERMACULTURE PRINCIPLES IN PRACTICE

An architecture grounded in permaculture principles would be based on the observation of natural systems, the wisdom contained in traditional human systems, and modern scientific and technological knowledge. Although based on good ecological models, permaculture creates a *cultivated* ecology, which is designed to create a comfortable and productive environment for human life. (Mollison 1991, 1) Permaculture is grounded in many disciplines: botany, biology, agriculture, horticulture, geography, architecture, anthropology, economics, and finance.

This type of integrative thinking is not new to the discipline of architecture. Vitruvius, in Chapter I of his Ten Books, details cross-disciplinary learning as a necessity for architects. He first emphasizes that architects must have a thorough knowledge of both theory and practice. He then enumerates the many fields in which architects must be well-versed: drawing, geometry, history, philosophy, music, drama, mathematics, medicine (for an understanding of the health effects of climate), law, and astronomy, in order to understand the path of the sun. (Vitruvius, 1st C. BCE, from Dover edition, 1960, 5-10)

Bill Mollison sums up permaculture as a practice of working with, rather than against nature; of protracted and thoughtful observation rather than protracted and thoughtless labor; and of looking at plants and animals in all their functions, rather than treating elements as a single-product system. He coined the term permaculture as a contraction of "permanent" and "(agri)culture." "The aim is to create systems that are ecologically-sound and economically viable, which provide for their own needs, do not exploit or pollute, and are therefore sustainable in the long term." (Mollison 1991, 1) The core of permaculture is design, the connection between things: "It's not water, or a chicken, or the tree. It's how the water, the chicken and the tree are connected." (Mollison 1991, 5)

Observing patterns is the basis for intelligent design. One should observe the patterns in a landscape daily; these are easily understood and repeated. For example, by watching snow melt across a field, one learns about solar aspect and microclimates. This helps determine where to plant lettuce vs. corn vs. tomatoes. Or where to site a resting place in the shade. (Bates 1998)

Permaculture principles may be broken down into seven major categories: conservation, stacking functions, multiple or repeating functions, appropriate scale, diversity, reciprocity, and giving away surplus. Similarities with another "canon" of ecological design, William McDonough's Hannover Principles, will be explored, as will the applicability of the principles to architectural practice.

CONSERVATION

Efficiency is the watchword with the practice of permaculture, which translates to conservation of energy in all its forms. According to teacher and practitioner Albert Bates, the idea is to design and create systems that allow the designer to pull back further out of the system as time goes on, eventually eliminating the need for a designer. Hence, the greatest amount of effort is expended at the earliest stages, with diminishing inputs following thereafter, as the system reaches its own self-regulating equilibrium. (Bates 1998) The key to efficient planning is the zone and sector system, which is summarized briefly here.

Zone planning means placing elements according to how often or intensely they are used or serviced. Zone 1 refers to the daily center of activity, usually a house, but at a larger scale it could be a village. (Mollison 1991, 9) Zone 2 is the immediate surroundings, where we work and play daily: the garden, studio, and other places of human interaction. Zone 3 is fully agricultural at a broad scale. It is still removed from daily activity and may be visited once a week. Zone 4 may be sustainable forestry, just slightly below wild, because it is managed. Zone 5 is wilderness, a "human exclusion" zone upon which we depend, but in a hands-off way. (Bates 1998) This diagram has much in common with Ebenezer Howard's Garden City, which also worked with concentric functional rings.

Sectors deal with the wild energies, the elements of sun, light, wind, rain, wildfire, and water flow (including flood) on a site. These all come from outside the system and pass through it. Sustainable site planning involves understanding and working with these energies, using them passively (such as natural convection), and even harvesting them (such as rainwater or solar heat). (Mollison 1991, 14) Sectors also refers to man-made flows, such as dust, pollution, noise, and vehicles, in order to comprehend and mitigate their influence on the site.

In a permaculture system, biological resources (plants and animals) are used wherever possible to save energy and to do the work of the farm. Building up biological resources on site is a long-term investment which needs thought and management in the planning stages and is a key strategy for recycling energy. The input at early stages of non-biological resources (such as fossil fuels) is acceptable if they are used to create long-term, sustainable biological systems and an enduring physical infrastructure. (Mollison 1991, 16)

Since the biological model is favored, this means that the designer thinks in terms of complete cycles, utilizing everything. As in nature, there is to be no waste, no pollution. A similar attitude is found in William McDonough's Hannover Principles, which remind us to do as plants do by relying on natural energy flows, such as solar income, and to eliminate the concept of waste by optimizing the full life-cycle of products and processes.(McDonough 1992, 5) Today even the most advanced building or factory in the world is still a kind of steamship, polluting, contaminating, and depleting the surrounding environment with its reliance on fossil fuels and petrochemicals. Imagine, instead, a building as a kind of tree. It would purify air, accrue solar income, produce more energy than it consumes, create shade and habitat, enrich soil, and change with the seasons. (McDonough 1998)

Permaculture systems seek to stop the flow of nutrients and energy off-site and instead turn them into cycles, so that, for instance, kitchen wastes are recycled to compost and household greywater flows to the garden. Good design uses incoming natural energies with those generated on-site to ensure a complete energy cycle.

The Adam J. Lewis Center for Environmental Studies at Oberlin College, designed by William McDonough and Partners, aspires to this ambitious goal of conservation, even if it doesn't yet fully succeed. It contains a "living machine" designed by John Todd, which will purify and recycle wastewater from the building. It also intends to be a net energy exporter, utilizing roof-mounted photovoltaics (PV's) and an aggressive energy-efficiency scheme. Many of the building's systems will be closely monitored, providing valuable feedback for fine-tuning and improvement.

STACKING FUNCTIONS

In every ecosystem different plant species occur at varying heights above the ground, and root structure at different depths. A garden can be planned to emulate a forest by planting an entire system all at once: climax species (long-lived orchard trees such as walnut or pecan); shorter-lived smaller fruit trees; faster-growing pioneers (acacia, autumn olive) for mulch, shade, and nitrogen; short-lived perennials (comfrey, yarrow) to provide weed control and mulch; perennial shrubs (blueberry); and even annuals such as dill, beans, and pumpkin. (Mollison 1991, 20-22) The idea is that each of these plants is doing more than one thing at a time: providing shade, enriching the soil, bearing fruit, giving nectar and pollen to bees.

This key concept – that every element should serve many functions – makes efficient use of space and labor. Another good example is a grape trellis over a path, which provides shade, but also allows maintenance to occur along the way, as a person passes by. (Bates 1998) A pond can be used for irrigation, watering livestock, aquatic crop, and fire control. It is also a habitat for waterfowl, a fish farm, and a light reflector. (Mollison 1991, 6) This versatility is both beautiful and elegant.

An architectural illustration is the BRE Office of the Future in Garston, Hertfordshire, UK, by Feilden Clegg Architects. The sine-curve floor slab is strong, conserves concrete, and performs many complementary functions at once. Its concave surface at the ceiling brings daylighting deep into the space; its efficient shape reduces the overall structural depth, raising the effective ceiling height and enhancing the indirect lighting scheme; its thermal mass stores cool nighttime ventilation air below the raised floor. This demonstrates how the simple choice of a rather unorthodox structural form solves multiple problems and contributes to the overall energy and resource efficiency of the building.

MULTIPLE/ REPEATING FUNCTIONS

Important basic needs such as water, food, energy, and fire protection should be served in two or more ways. A house with a solar hot water system may also contain a back-up woodstove with a water jacket to supply hot water when the sun is not shining. Water itself may be caught in a variety of ways on a site, from dams and tanks to swales and chisel plowing (to replenish groundwater). (Mollison 1991, 8) Another word for this is resilience. If one system fails or falters, others can take over.

This redundancy to meet needs in various ways is illustrated simply by the requirement for multiple means of egress in buildings. If fire blocks one's path, there are alternate choices for escape. A more complex example is the Gštz Headquarters in WŸrzburg, by Webler + Gesler Architects. The exterior is clad in a glazed thermal buffer, or double-curtain wall. With its two layers of glass, this buffer acts like a thermal chimney while simultaneously allowing ample daylight into the offices. As the air between the glass heats up, it is drawn naturally up and out of the top, effectively reducing heat gain within the building. Louvers within this cavity further allow control of direct solar gain and glare. This system is supplemented by fans which drive warm air from the south façade to the colder north façade during the winter. The job of reducing energy use by minimizing heat gain in summer and of making use of it in winter is important enough to be performed by several elements.

APPROPRIATE SCALE

Small-scale, intensive systems means that 1)much of the land can be used efficiently and thoroughly, and 2)the site is under control. If we cannot maintain or improve a system, we should leave it alone, thus minimizing the damage and preserving natural complexity. Mollison proposes that perhaps we should only cultivate or settle those areas which we can establish, maintain and harvest by small technologies as a form of control over our own appetites. (Mollison 1991, 20) The caution here is to be aware of limits at all times. If limits are exceeded, the system will be pushed to collapse.

Another parallel with McDonough's Hannover Principles becomes apparent. Principle #8 says that we should understand the limitations of design. No human creation lasts forever and design does not solve all problems. This humility allows us to treat nature as a model and mentor, not an inconvenience to be evaded or controlled. (McDonough 1992, 5) Our environment bombards us daily with examples of what not to do. Suburban housing developments go onto a site with bulldozers to create a "clean slate" for their executive-mansion monoculture. The resulting "delinquent landscape" (Mollison's term) is highly energy-intensive and not sustainable.

More promising in the U.S. is the popularity of the book, *The Not-So-Big House*. The message is that smaller is better, because homes can be intelligently and creatively planned around a specific family's needs.

DIVERSITY

Diversity is often related to stability. Although the yield of a monoculture system will probably be greater for a particular crop than the yield of any one species in a permaculture system, the sum of yields in a mixed system will be larger. Stability refers not so much to the number of elements in a system, but to the number of *functional connections* between those elements. A system with diverse plant and animal species, habitats, and microclimate reduces the chance of a bad pest situation, thus is more resilient. (Mollison 1991, 24-25) Living systems provide for their own replacements, grow to optimize available space and nutrients, seek companionship, satisfaction, and stability and solve problems. (Bates, 1998)

William McDonough sees respect for diversity as a key ingredient in the "Next Industrial Revolution." Designs will respect the regional, cultural, and material uniqueness of a place. Wastes and emissions will regenerate rather than deplete, and design will be flexible, to allow for changes in the needs of people and communities. For example, office buildings will be convertible into apartments, instead of ending up as rubble in a construction landfill when the market changes. (McDonough 1998)

Older industrial buildings such as the lofts in Soho, New York, have proven to be quite adaptable to new uses. The abandoned American Can Company buildings in Baltimore, Maryland were recently given new life as a mixed-use, office, retail, and restaurant complex. The variety of uses draws all sorts of people to the site and has acted as a catalyst for the revitalization of the entire neighborhood.

RECIPROCITY

This principle deals as much with human attitudes as with design principles. Every resource is either an advantage or a disadvantage, depending on the use made of it. (Mollison 1991, 30) Recalling that in nature, elements have no product unused by other elements in the system, something that seems to be a liability can actually be an asset. At the same time, elements have their own needs supplied by other elements in the system, which completes the cycle.

The Eco-Industrial park at Kalundborg, Denmark, is an excellent example on a large scale of a circular metabolism, or the connecting of the wastes and inputs of different businesses and industries. Truly symbiotic relationships have developed between a power plant, an oil refinery, a pharmaceutical company, a plasterboard maker, and the municipality of Kalundborg. The power plant provides excess heat energy to the municipality for use in its district heating system, provides heat to a fish farm, sells steam to the refinery, and provides gypsum from its stack scrubbers to the plasterboard maker. It also sells flyash to local construction firms. (Beatley 2000, 242-243)

GIVE AWAY

After basic needs are taken care of, we should share any surplus, whether of time, food, labor, energy, money, information, or creativity. A surplus is easily produced, but can be used either well or badly. Choosing wisely will apply surpluses to further the aims of care of the earth and care of the people. (Bates 1998)

One simple way this can apply to architecture is in the production of energy within the building. Grid-connected buildings can utilize a PV system to produce power, and through net-metering, send excess power back to the local utility. The Sacramento, California Municipal Utility District (SMUD) has the "Solar Pioneers" program, which finances the installation of PVs on homes and commercial buildings for decentralized power production. (Strong 1999, 99-100)

CONCLUSIONS

In teaching sustainable design, it is useful to structure the studio around fundamental principles. It is especially valuable when these concepts overlap, reinforcing what can be seen as universal values. For instance, William McDonough's Hannover Principles are remarkably in sync with those of Permaculture. Both remind us to accept responsibility for the consequences of design decisions upon human well-being, the viability of natural systems, and their right to co-exist. They also encourage constant improvement by sharing knowledge between colleagues, patrons, manufacturers and users. (McDonough 1992, 5)

The value of permaculture is that it provides both principles and practical experience. Grounded in many disciplines, these principles are put into practice all over the world in a variety of ways specific to each place. Heathcote Community provides a working model of the ongoing experimentation and struggle to live sustainably and take responsibility at several scales for the consequences of one's actions. As an illustration of this thoughtfulness, member Charles Curtiss bases his purchasing decisions on four questions: Where did this come from? What did it take to get it to me? What does it take to use it? What happens to it when I am through with it? These could be quite a useful guide in the practice of architecture, assuming the availability of hard data to support one's decisions.

During this studio, the students encountered a mind-boggling amount of information, which they had to sift through and evaluate. Happily, they did learn enough about the subject matter to talk intelligently about their decision-making process and, perhaps more importantly, to understand it as a series of well-informed value judgments. As one student said at the final review, "None of us can ever look at design the same way again."

The emphasis on permaculture also helped them to recognize the critical importance of getting to know the site intimately before committing to building anything. Some designs speculated on the potential for an armature or structure to allow adaptation as more is learned about the site. This is a highly advanced notion, suggestive of the Center for Maximum Potential Building Systems near Austin, Texas, a site and structure that has been evolving and changing for many years now.

Students appreciated the encouragement to think about the *quality* of places, to design for the emotions and senses as well as to satisfy abstract criteria. So much of architectural education is necessarily abstract, there is the tendency to lose track of tangible experiences of space. On the other hand, projects suffered from a lack of hard analysis of their technical aspects. Although students learned and used Energy-10 for this project, there was still a demonstrable need for a good, basic understanding of how heat, cold, and moisture move through a building. As a companion to intuition, students need to quantify how much thermal mass or insulation is needed, and whether heating or cooling is the limiting factor. Studio projects could establish acceptable energy budgets and teach students how to analyze and quantify energy use early in their design process.

During a post-semester faculty meeting, one of my colleagues asked these questions: Is this discipline a source of form? Is it a special interest? Or, is it a template to be thrown around all buildings? In a sense, one could answer yes to all. In the same way that permaculture practice varies widely from place to place, the structure and application of design studios would vary, even with commonly-held underlying ecological principles.

After decades of study and observation, ecologists have taught us enough to begin to divine a canon of nature's laws, strategies, and principles that apply to our own endeavors. Nature runs on sunlight; uses only the energy it needs; fits form to function; recycles everything; rewards cooperation; banks on diversity; demands local expertise; curbs excesses from within; and taps the power of limits. (Benyus 1997, 7) Modeling architecture on these laws is not a punishing sacrifice, nor does it lead to aesthetic impoverishment. Indeed, this work will inspire us to redefine our concept of art, to "cultivate a new standard that defines beauty as that which causes no ugliness somewhere else or at some later time." (Orr 1999, 218)

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